

<u>Step 1</u>	<u>Step 2</u>	<u>Step 3</u>	<u>Step 4</u>	
<u>Enter Test Setup Data</u>	<u>Test Planning Sheet</u>	<u>Enter Test Data</u>	<u>View Results</u>	<u>View Charts</u>

Version 1.2  
12/03/03

## Introduction

The purpose of the California State Lands Commission Hydrostatic Test workbook is to provide a useful alternative to facilitate hydrotest planning, performance and interpretation. This process is broken down into 4 steps: test setup data, test planning calculations, actual test data, and interpretation of results. Each spreadsheet throughout the workbook has an accompanying help button:

Help

When clicked, this help button will provide definitions and explanations for each entry in that section. Following is a brief breakdown of the step-by-step process of using this workbook.

## Step 1 - Test Setup Data

The first step consists of entering pipeline/testing data in order to allow identification of the pipeline and tester, and to allow pressure/volume/temperature calculations for the duration of the hydrotest. There are three components of the Test Setup Data.

1. **Pipe Identification** - This section is used to identify the pipeline, the people and companies involved in the testing, and the purpose of the test. The only entries that are used for calculations (rather than basic record-keeping) are the minimum flange rating and pressure-limiting component. These values are checked against the planned test pressure and a warning will be generated if the planned test pressure is greater than 95% of the maximum rated pressure for the system.
2. **Pipe Data** - The geometry of the pipeline system is defined in this section, including length, diameter and wall thickness. This data is required for accurate calculation of the relationship between pressure, volume and temperature during the hydrotest.

First, the number of pipeline segments included in the pipe under test must be defined. This may vary from one to twenty-five segments. Each variation in pipe diameter and wall thickness should be entered as an individual segment. Also, each aboveground/underground portion of the pipe should be entered as individual segment. If two temperature measurement devices are to be used on one section of pipe, it must be broken into two segments, with one temperature instrument device assigned to each segment. For example, a system consisting of:

100 ft 12" xs aboveground pipe  
200 ft 12" std aboveground pipe  
300 ft 12" std underground pipe  
400 ft 8" std aboveground pipe (with 2 equally-spaced temperature probes)

would be entered as:

PIPE DATA			Number of Segments:	5	Number of Temperature Instruments			4		
Segment Number	Pipe OD (in)	Wall Thickness	Specification & Grade	SMYS	Above ground or Below ground	Weld Joint or Other Derating Factor	Temperature Instrument ID #	Length Tested (ft.)	Volume (gallons)	
1	12.75	0.500	A-106 GR-B	35,000	Aboveground	1.0	1	100	563	
2	12.75	0.375	A-106 GR-B	35,000	Aboveground	1.0	1	200	1,175	
3	12.75	0.375	A-106 GR-B	35,000	Belowground	1.0	2	300	1,763	
4	8.625	0.322	A-106 GR-B	35,000	Aboveground	1.0	3	200	520	
5	8.625	0.322	A-106 GR-B	35,000	Aboveground	1.0	4	200	520	

Note that 4 temperature probes have been defined for this example. One for the first two aboveground segments, one for the underground segment, and the two initially defined on the 8" pipe segment. Normally, each aboveground and underground pipe segment should have a separate temperature instrument, since there will be less significant temperature change on the underground segment than on the aboveground segment because both the baseline temperature when the test commences and the temperature variation during the test will be different between the aboveground and underground segments.

between the aboveground and underground segments.

3. **Test Setup Information** - This section defines the pressure and temperature instruments, and verifies that they have been tested within 3 years of the hydrotest date. Elevations are also entered for use in checking the test pressure against maximum rated system pressure.

### **Step 2 - Test Planning Calculations**

There are only three pieces of information that need to be entered in this section.

The planned test pressure should be entered for physical property calculations and to compare with the rated pressure of the piping.

The fluid that is to be used must also be entered; water is the most common fluid used for testing, but other typical fluid properties are also available. Note that these properties are not exact, as there is significant deviation between different blends of the same product. If more specific physical properties are known for the product in use, these should be entered manually.

Finally, an expected temperature must be entered. This must be completed before the actual hydrotest is performed in order to calculate the allowable pre-test dV/dP, but the temperature should be revised after completion of the test for more accurate physical property calculations. Normally the "Recorder Data" option should be selected after test completion; this calculates a weighted average of the recorded temperatures throughout the course of the test.

The last two pages in the Test Planning Calculation section are dedicated to calculating the theoretical dV/dP (the change in volume associated with a pressure increase of 1 psi) and dV/dT (the change in volume associated with a temperature increase of 1° F).

At the bottom of the dV/dP calculation sheet, the allowable range of pre-test dV/dP values are listed. This is the range between 95% of the theoretical dV/dP and the dV/dP associated with having 1% initial trapped air (volume basis). The purpose for this calculation is to ensure that there is a tight pack on the line before beginning the hydrotest, in order to prevent wasted time on a test that will not be able to pass, due to excessive air. This calculation is pressure-dependant, and is based upon bleeding down the line from 50 psig to 40 psig. See the *Hydrotest Procedure* for more information.

### **Step 3 - Test Data**

This section is similar to other worksheets currently available for tracking pressure and temperature throughout the course of the hydrotest. The official beginning of the hydrotest should be marked with "Start" in the Start/Stop column. The official end of the hydrotest should likewise be marked with "Stop." Any data outside of this range will not be considered in hydrotest calculations and will be preserved only for later reference.

Temperature data is typically entered one instrument at a time. That is, the instrument in question should be selected from the instrument selection drop-down box. The temperatures over the course of the test for that instrument are then entered. It is important to press the "Save Temp. Data" after the temperature information has been entered, or else the values will not be saved. If there are many temperature instruments, one can bypass the instrument-by-instrument data entry format, by selecting "ALL" from the drop-down instrument selection box. This will bring up all of the temperature instruments simultaneously, to allow for quicker data entry.

### **Step 4 - View Results**

The View Results worksheet presents a summary of the volumes associated with injection/bleed, temperature change, and pressure change for the duration of the hydrostatic test. This follows the basic format originally presented by the California State Fire Marshall, summarizing the results as "Computed Volume Change."

The pre- and post-test bleed data should be entered, producing actual dV/dP values, which are compared with the theoretical as a check against excessive trapped air or other testing error. The option of using the theoretical or actual dV/dP data is provided. Normally the theoretical value is used; in cases where there is significant variation between the theoretical and actual values, the actual value can be used instead. This worksheet is mainly provided as a point of reference for those that feel most comfortable with the existing CSFM spreadsheet. Normal acceptance criteria are provided in the Charts worksheet.

The Charts worksheet displays the actual pressure for the duration of the hydrotest. It also displays the theoretical pressure (the pressure that is predicted based upon the reported changes in temperature and the volume injected/bled). The acceptable pressure range is shown on the graph, as lines above and below the theoretical pressure. This value is calculated as the expected accuracy, assuming temperature change can be accurately measured to within 1° F (0.1° F for hydrocarbons, due to the increased sensitivity of hydrocarbons to temperature) and pressure measurement can be recorded to within 1 psi. This level of measurement accuracy (1°/0.1° F) should not be confused with the precision required out of the temperature instrument (0.1°/0.01° F); while the instrument should be able to get to the stated levels of precision, the accuracy with respect to the actual pipe segment bulk temperature is expected to be closer to the larger values. If the actual test pressure falls within the acceptable test range throughout the course of the test, the data correlates and the test can be considered to pass. See the *Hydrotest Procedure* for more details on what constitutes a successful test.